Reversible natural reflectance switching mechanisms in Panamean Tortoise Beetles

Jean Pol Vigneron[1], Jacques M. Pasteels[2] and Donald M. Windsor[3]
Jean-François Colomer[1], Victoria Welch[1], Olivier Deparis[1], Cédric Vandenbem[1], Damien Ertz[4], Marie Rassart and Virginie Lousse[1]
[1]Laboratoire de Physique du Solide, Facultés Universitaires Notre-Dame de la Paix, 61 rue de Bruxelles, B-5000 Namur Belgium
[2]Université Libre de Bruxelles, Campus de la Plaine, B-1000 Bruxelles Belgium
[3]Smithsonian Tropical Research Institute, Smithsonian Institution, Roosvelt Ave., Tupper Building 401 Balboa, Ancón, República de Panamá
[2]Université Libre de Bruxelles, Campus de la Plaine, B-1000 Bruxelles Belgium
[4]National Botanic Garden of Belgium, Domaine de Bouchout, B-1860 Meise, Belgium

The Tortoise Beetle *Charidotella egregia* (Cassidinae) is a 5-to-7 mm-long insect that usually lives on the host plant *Ipomoea lindenii*, and can be found at the border of the rainforest of the American continent. This insects shows the intriguing particularity of being able to drastically change color (from yellow to red), and to switch from metallic to diffuse reflection, when it gets "upset" by some external conditions, such as an attempted predator attack. When safer conditions are recovered, it can easily restore its dorsal cuticle into its original metallic-gold looking state.

Biological observation, optical measurements carried out on living beetles captured in their habitat, electron microscopy applied to dried specimens, and numerical simulations, are presented to provide evidence that the exocuticle of this beetle is a metamaterial with a photonic structure which has evolved to show a high sensitivity to internal hygrometric variations. This suggests a new multiphysics mechanism (including optics and hydrodynamics) for producing slow but deep changes in the visual aspect of very large, macroscopic, surfaces. The idea could be generalized to produce a broad class of selective surfaces with optical properties which can be reversibly switched on and off.